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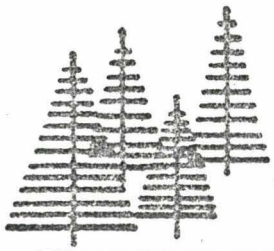

FOREST PEST MANAGEMENT

STATE & PRIVATE FORESTRY

R4-83-11
July 1983

EFFECTIVENESS OF SOIL FUMIGATION IN REDUCING PATHOGENIC SOIL FUNGI AT THE UTAH STATE NURSERY

By
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INTRODUCTION

The Utah State Nursery at Draper, Utah, operated by the Utah Division of State Lands and Forestry, produces softwood seedlings from seed and hardwood seedlings from cuttings and seed. The nursery has been plagued by a chronic weed problem resulting from soil-borne and windblown weed seed. A weed management plan prepared by Tom Landis, Western Nursery Specialist, USDA Forest Service, recommended soil fumigation with a mixture of 67-percent methyl bromide and 33-percent chloropicrin to eradicate weed seeds within the treated soil strata [1/]. At the request of Dan Hendriksen, Nurseryman, Utah State Forest Nursery, I conducted pre- and post-fumigation surveys to determine the effects of soil fumigation on the populations of soil-borne plant pathogenic fungi in Blocks 1 and 10.

METHODS

Site History

The nursery is located at the Utah State Prison. Fifteen years ago, the site was used to grow alfalfa. Following this, the site was used as a pasture for cattle until 1975 when the first crop of hardwoods was grown in Block 1. Between 1975 and 1982, Block 1 was used to grow conifers, including ponderosa pine, Austrian pine, Scotch pine, and blue spruce. Block 10 had not been planted with trees prior to 1982. The soil in Block 1 is a sandy loam; whereas, in Block 10, it is a silty loam. Blocks 1 and 10 were fumigated on April 21 and 22, 1982, with a fumigant consisting of 67-percent methyl bromide and 33-percent chlocopicrin. The fumigant was injected 6 inches into the soil at a

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1/ Landis, T. D. 1982. Weed Management Plan - Prepared for Utah State Seedling Nursery. USDA Forest Service, State and Private Forestry, Rocky Mountain Region. 11 p. unpublished report.

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rate of 350 to 400 pounds per acre and covered immediately with a plastic tarp. The glue-seam and overlap technique was used to ensure complete coverage by the tarp. Tarps were left in place for 24 hours to allow diffusion of fumigant throughout the soil. A portion of Block 10 was not fumigated because of inadequate tarp and fumigant.

Soil Sampling

Twelve sampling points were established in Block 1 (Figure 1) and 10 points in Block 10 (Figure 2). At each sampling point, five soil cores were extracted from the top 6 inches of the soil profile using a soil probe. One core was extracted at the plot center, and the rest were extracted 6 inches from the center at each cardinal direction. The five cores were mixed and transfered to a labeled bag. Samples were stored under refrigeration until processing in the Forest Pest Management Laboratory in Ogden, Utah.

In the laboratory, each soil sample was thoroughly mixed and divided into two portions. Population levels for Pythium spp. were estimated by diluting 5 grams of field-moist soil in 10 ml. of 0.5 percent water agar solution, and plating 1 ml. on a medium selective for Pythium spp. (Hendrix and Kuhlman 1965). Population levels for Fusarium spp. were estimated by diluting 0.1 grams of air-dried soil in 40 ml. of 0.1-percent water agar solution, and plating 1 ml. on a medium selective for Fusarium spp. (Komada 1975). Population estimates in propagules per gram (ppg) of soil were calculated from counts of colonies per plate.

Three sets of samples were collected from the established plots. (1) two days before fumigation, (2) one month after fumigation, and (3) ten months after fumigation. The sample means for each set within a block were compared using the t test.

RESULTS AND DISCUSSION

Pre-fumigation levels of Fusarium spp. (Table 1) and Pythium spp. (Table 2) at the Utah State Nursery are similar to levels found at Mt. Sopris Tree Nursery, Carbondale, Colorado (Fuller et. al. 1980). Pre-fumigation levels of Fusarium spp. are higher than those found at the Lucky Peak Forest Nursery, Boise, Idaho (Marshall 1983). The Lucky Peak beds had been fumigated 2 years before the survey, whereas, the beds at the Utah State Nursery had never been fumigated prior to 1982.

Fumigation was very effective in reducing levels of Fusarium spp. and Pythium spp., as evidenced by population levels one month following treatment in Block 1 (Tables 1 and 2). As mentioned earlier, a portion of Block 10 was not fumigated. This included plots 10-2, 10-3, 10-5, 10-7, and 10-8. Removing these plots from the statistical analysis revealed that populations of both pathogens were also reduced in the fumigated portions of Block 10 (Tables 1 and 2). The population levels in the unfumigated plots in Block 10 did not differ significantly ($p = .05$) for the three sampling periods.

Soil sampling ten months following fumigation indicated amounts of reinfestation by the pathogens. Population levels of Fusarium spp. remained low in Block 1 but rebounded in Block 10. Pythium spp. levels in Block 1 increased

over the 1-month post-fumigation levels but were not as high as the pre-fumigation levels. In Block 10, the levels of Pythium spp. also rebounded to pre-fumigation levels. Reinfestation in Block 10 was greater than in Block 1, probably because a central strip was not fumigated. Vaartaja (1967) found that reinfestation of sterilized nursery beds occurs by means of splashing rain and irrigation water, dust, and soil carried by man. He concluded that "elimination of pathogens would be feasible only if all tools, boots, and soil, including paths, were fumigated simultaneously and if very large areas were included in the sanitation program." Attempting such sanitary nursery operations appears impractical; however, careful fumigation of an entire block should reduce the rate of reinfestation. Hosing down equipment and boots when going from unfumigated to fumigated blocks should also reduce reinfestation.

RECOMMENDATIONS

1. Continue fumigating seedbeds prior to sowing using a mixture of methyl bromide and chloropicrin to prevent seedling losses to pathogenic fungi.

2. Fumigate entire blocks using glue-seam and overlap technique to ensure complete coverage by the tarp. Fumigating large areas reduces the rate of reinfestation by pathogens from surrounding untreated soils.

3. Further soil sampling for pathogens may not be necessary since the effectiveness of fumigation at the Utah State Nursery has been demonstrated.

4. Continue monitoring germination and seedling survival, and contact Forest Pest Management staff if insect or disease problems occur.

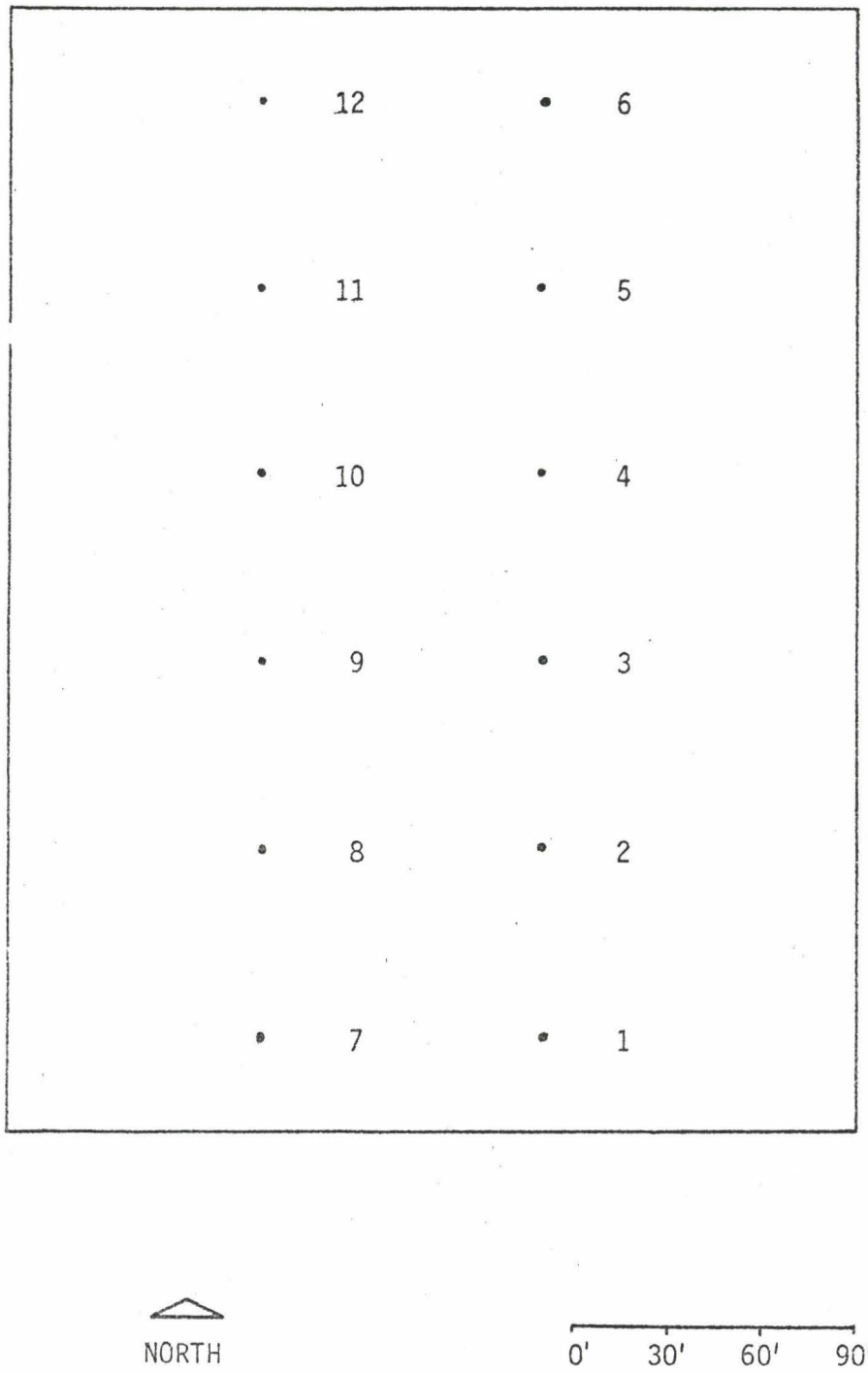

Figure 1. Location of soil sampling plots in Block 1 at the Utah State Forest Nursery.

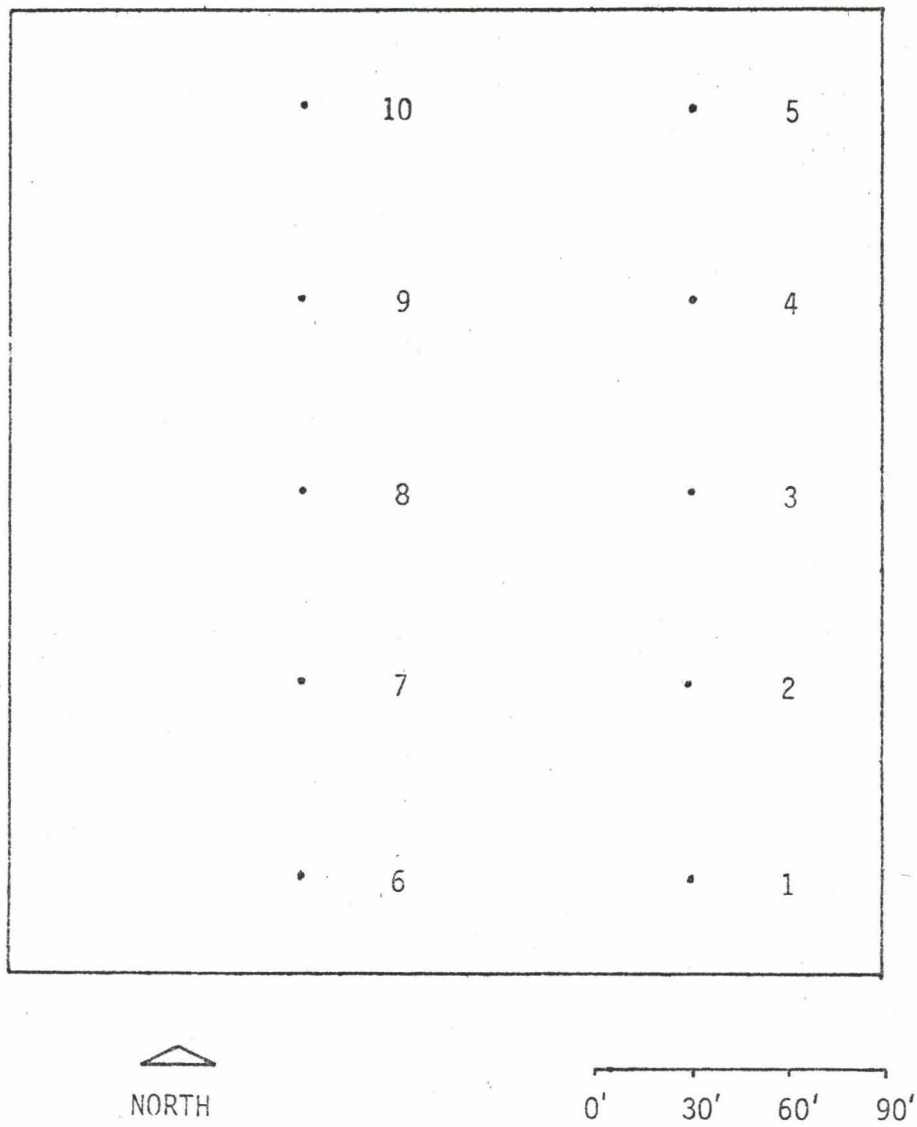

Figure 2. Location of soil sampling plots in Block 10 at the Utah State Forest Nursery.

Table 1. Levels of *Fusarium* spp. by sample point before fumigation and at 1 and 10 months after fumigation.

Block/Plot	Pre-fumigation	1 month Post-fumigation	10 months Post-fumigation
	Propagules per gram 1/		
1-1	4800	0	0
1-2	6800	0	400
1-3	11600	0	0
1-4	12800	3200	0
1-5	3200	0	0
1-6	6000	5600	3200
1-7	6000	0	2000
1-8	6000	400	1200
1-9	5200	0	0
1-10	8400	0	0
1-11	4800	0	0
1-12	9200	0	0
$\bar{x}$	7066.7[a] 2/	766.7[b]	566.7[b]
10-1	3600	0	0
10-2	2400	7600	800
10-3	5600	4000	2400
10-4	1600	0	11200
10-5	1600	1200	1200
10-6	11600	0	0
10-7	4000	3600	4800
10-8	6400	8800	2400
10-9	3200	0	3600
10-10	6400	0	1200
Overall $\bar{x}$	4640[c]	2520[c]	2760[c]
Fumigated $\bar{x}$	5280[d]	0[e]	3200[d]

1/ Propagules of *Fusarium* spp. per gram of dried soil.

2/ Means in the same horizontal row followed by the same letter are not significantly different ($p = .05$) according to the t test.

Table 2. Levels of *Pythium* spp. by sample point before fumigation and at 1 and 10 months after fumigation.

Block/Plot	Pre-fumigation	1 month Post-fumigation	10 months Post-fumigation
	Propagules per gram 1/		
1-1	96	0	12
1-2	90	0	4
1-3	170	0	10
1-4	154	42	56
1-5	174	0	10
1-6	144	38	232
1-7	108	0	14
1-8	98	0	38
1-9	150	0	66
1-10	140	0	88
1-11	140	0	98
1-12	118	0	6
$\bar{x}$	131.8^{a} 2/	6.7^{b}	52.8^{c}
10-1	36	0	24
10-2	72	62	36
10-3	26	28	82
10-4	32	0	34
10-5	48	20	24
10-6	84	0	56
10-7	74	64	76
10-8	64	68	76
10-9	60	0	42
10-10	42	0	60
Overall $\bar{x}$	53.8^{d}	24.2^{d}	51.0^{d}
Fumigated $\bar{x}$	50.8^{e}	0^{f}	43.2^{e}

1/ Propagules of *Pythium* spp. per gram of field-moist soil.

2/ Means in the same horizontal row followed by the same letter are not significantly different ($p = .05$) according to the t test.

LITERATURE CITED

Fuller, L. R., L. S. Gillman, and D. M. Hildebrand. 1980. Reduction of pathogenic soil fungi at Mt. Sopris Tree Nursery and Big Sioux Conifer Nursery using Dowfume® MC-33. USDA Forest Service Forest Insect and Disease Management, Rocky Mountain Region. Biological Evaluation R2-80-1. 13 p.

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PESTICIDE-USE STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key--out of the reach of children and animals--and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Department of Agriculture, consult your county agricultural agent or State Extension specialist to be sure the intended use is still registered.